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BURKHART, ELIZABETH A	
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BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte RAMGOPAL DAROLIA,
IRENE SPITSBERG, and
BRETT ALLEN ROHRER BOUTWELL

Appeal 2009-005819
Application 10/707,469
Technology Center 1700

Decided: June 14, 2010

Before BRADLEY R. GARRIS, PETER F. KRATZ, and
MARK NAGUMO, *Administrative Patent Judges*.

NAGUMO, *Administrative Patent Judge*.

DECISION ON APPEAL

A. Introduction[1]

Ramgopal Darolia, Irene Spitsberg, and Brett Allen Rohrer Boutwell ("Darolia") timely appeal under 35 U.S.C. § 134(a) from the final rejection[2] of claims 1-20, 33, and 34, which are all of the pending claims. We have jurisdiction under 35 U.S.C. § 6. We REVERSE.

The subject matter on appeal relates to processes of applying a ceramic thermal barrier coat ("TBC") to a substrate. TBCs are applied to substrates such as turbine blades that experience extreme heat during use. According to the 469 Specification, these coatings are often produced by electron beam physical vapor deposition (EBPVD) of binary yttria (Y_2O_3)-stabilized zirconia (ZrO_2) ("YSZ"). However, the thermal conductivity is said to rise during service (Spec. [0003]) due to changes in the microstructure of the TBC (*id.* at [0004]). The 469 Specification discloses that it is known to reduce the thermal conductivity of YSZ by adding rare earth metal oxides such as lanthana (La_2O_3) or neodymia (Nd_2O_3), which increase lattice defects or introduce lattice strains. (*Id*. at [0003].) Efforts to produce such TBCs by vapor deposition techniques are said to be complicated by differing vapor pressures (as much as an order of magnitude) of the rare earth metal oxides compared to zirconia and yttria. (*Id.* at [0004].) Procedures are said to have been developed to overcome these

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[1] Application 10/707,469, *Process and Apparatus for Depositing a Ceramic Coating*, filed 16 December 2003. The specification is referred to as the "469 Specification," and is cited as "Spec." The real party in interest is listed as General Electric Company. (Appeal Brief, filed 8 August 2008 ("Br."), 3.)

[2] Office action mailed 16 October 2007 ("Final Rejection"; cited as "FR").

problems, but the procedures are said to be complicated, and it remains difficult to obtain uniform distributions of various components in the TBC. (*Id.*)

The claimed invention aims to overcome these problems by evaporating YSZ and carbides such as YbC_2, NdC_2, and LaC_2 by bombardment with an electron beam in an atmosphere containing sufficient oxygen to oxidize metal dissociated from the carbide. (Spec. [0008].) YSZ is said to be co-deposited with the rare-earth oxides, which create lattice defects and strains in the YSZ lattice, and with carbides, carbon, and carbon-containing gases, which are said to promote stable porosity in the thermal barrier coating. (*Id.*)

Illustrative claim 12 is reproduced from the Claims Appendix to the Principal Brief on Appeal:

> 12. A process of depositing a thermal barrier coating on a surface of a gas turbine engine component, the thermal barrier coating comprising
>
> > yttria-stabilized zirconia and
> >
> > an oxide of a metal chosen from the group consisting of ytterbium, neodymium, lanthanum, and combinations thereof,
>
> the process comprising the steps of:
>
> > placing the component in a coating chamber containing at least one ingot that provides
> >
> > > zirconia, yttria, and
> > > a carbide compound of the metal;
> >
> > projecting a high-energy beam on the at least one ingot in the presence of oxygen to
> >
> > > melt the at least one ingot,

dissociate the metal from the carbide compound,
oxidize the metal, and
form a vapor cloud; and

allowing the vapor cloud to contact and condense on the component to form the ceramic coating,
the ceramic coating comprising
yttria-stabilized zirconia,
the oxide formed by oxidation of
ytterbium, neodymium, and/or lanthanum present as a result of dissociation of the carbide compound, and
a uniform distribution of at least one of
elemental carbon and CO.

(Claims App., Br. 24-25; indentation and paragraphing added.)

Claim 1 is similar but broader in several respects, most importantly in that no particular oxides or carbides are named.

The Examiner has maintained the following ground of rejection:[3]

> Claims 1-20, 33, and 34 stand rejected under 35 U.S.C. § 103(a) in view of the combined teachings of the Rigney Application[4] and the Rigney Patent.[5]

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[3] Examiner's Answer mailed 2 October 2008. ("Ans.").

[4] Joseph David Rigney and Ramgopal Darolia, *Yttria-Stabilized Zirconia with Reduced Thermal Conductivity*, U.S. Patent Application Publication US2002/0172838 A1 (21 November 2002).

[5] Joseph David Rigney and Ramgopal Darolia, *Thermally-Stabilized Thermal Barrier Coating and Process Therefor*, U.S. Patent 6,492,038 B12 (10 December 2002).

B. Discussion

Findings of fact throughout this Opinion are supported by a preponderance of the evidence of record.

The Examiner relies on the Rigney Application for disclosure of forming a TBC comprising YSZ and lanthanum- or neodymium-oxide by evaporating YSZ and a metal in the presence of oxygen, which oxidizes the metal vapor to deposit the oxide of the metal along with the YSZ. (FR 2, citing the Rigney Application, page 4, para. [0024].) The Examiner admits that the Rigney Application is silent as to the presence of a metal carbide in the source ingot, and silent as to the ceramic coating containing carbon, a carbon containing gas, or precipitates of a carbide compound. (FR 2.) To remedy these deficiencies, the Examiner relies on the Rigney Patent for disclosure of an EBPVD process in which YSZ and carbide are evaporated in an atmosphere containing oxygen, resulting in deposition of a thin durable thermal barrier coating comprising YSZ and carbide-based precipitates. (*Id.* at 3.) The Examiner reasons that it would have been obvious to use the carbide compounds suggested by the Rigney Patent in the process taught by the Rigney Application in order to obtain thinner TBCs. (*Id.*)

Darolia does not address any of the dependent claims separately. With respect to claim 1, Darolia argues that the Examiner erred in combining the two references because there would have been no reasonable expectation of successfully conducting the claimed process, which involves the dissociation of the carbide and the subsequent oxidation of the metal and carbon, and the subsequent deposition of metal oxide, elemental carbon, carbon-containing gas, or carbide, because the Rigney Patent does not

disclose the metal is available to be oxidized. (Br. 17.) Moreover, the Rigney Patent does not, according the Darolia, teach or suggest oxygen in excess of the amount required to reform the TBC material dissociated during evaporation, i.e., sufficient oxygen to oxidize the metal in the vapor cloud. Adding additional oxygen, Darolia argues, would have been counterproductive to the goal of depositing a YSZ coating that contains carbide taught by the Rigney Patent. (*Id.* at 18.)

As for independent claim 12, Darolia argues further that the Rigney Application discloses coatings containing only metal oxides, while the Rigney Patent discloses coatings containing only metal oxides and carbide or nitride precipitates. Neither, Darolia argues, teaches or suggests the production of coatings containing additionally elemental carbon or carbon monoxide. (Br. 19.)

The Examiner responds that the Rigney Application "discloses providing a sufficient amount of oxygen to the chamber to oxidize a metal vapor while YSZ is being evaporated in order to co-deposit a metal oxide in the coating to reduce the thermal conductivity [0009], [0024]." (Ans. 6) The teaching of the Rigney patent to evaporate carbides to obtain thinner coatings, the Examiner argues, would have suggested the combination of carbides with yttria and zirconia, "wherein a suitable supply of oxygen may be provided which would oxidize dissociated metal vapor to incorporate a metal oxide in the coating to reduce thermal conductivity." (*Id.*)

Review of the passages cited by the Examiner, as well as the entire Rigney Application, indicates the Examiner is relying on disclosure of an alternative method in which metal vapor may be "continuously introduced

into the coating chamber, and which in the presence of oxygen oxidizes to deposit the oxide of the metal along with YSZ evaporated from the YSZ ingot." (Rigney Application, [0024], penultimate sentence.) Similarly, the Examiner relies on an alternative disclosure in the Rigney Patent in which, rather than using methane, benzene, or toluene gas as a source of carbon (Rigney Patent, col. 5, ll. 23-29), the TBC ingot material is "altered to contain carbon, a carbon-containing compound, or a carbide or nitride" (*id.* at ll. 56-58.)

As pointed out by Darolia (Br. 17), the critical fact the Examiner has failed to establish is that those skilled in the art would have recognized that the metal carbides would dissociate to metal atoms and carbon under the EBPVD conditions, and that the subsequent oxidation products would be incorporated into the ceramic TBC. Although both the Rigney Application and the Rigney patent are concerned with ways of improving TBCs, the Examiner has failed to show that a person having ordinary skill in the art would have made YSZ coatings containing La_2O_3 or Nd_2O_3, as taught by the Rigney Application, by introducing lanthanum carbide or neodymium carbide as a source of La or of Nd. The Rigney Application, as Darolia points out (*id.* at 19), makes no mention of metal carbides for any purpose. The Rigney Patent teaches the introduction of "extremely fine carbide-based and/or nitride-based precipitates formed at the defects and pores of the TBC microstructure, as well as on the grain boundaries of the TBC." (Rigney Patent, col. 2, ll. 58-62.) The Examiner's argument that "at least a portion of the metal dissociated would have been expected to reform carbide precipitates" (Ans. 6) is not persuasive because the Examiner has not

directed our attention to any disclosure in the Rigney Patent indicating a recognition that the decomposition of carbides is known or desirable under the disclosed conditions. It cannot be obvious to take advantage of a phenomenon that is not recognized.

The weakness of the rejection is further highlighted by the reliance on alternative disclosures in each reference, neither of which is discussed in significant detail. In summary, the rejection lacks a solid evidentiary foundation. Instead it relies improperly on speculation and on inherency that arises out of the combination of the references. We therefore REVERSE.

C. Order

We REVERSE the rejection of claims 1-20, 33, and 34 under 35 U.S.C. § 103(a) in view of the combined teachings of the Rigney Application and the Rigney Patent..

REVERSED

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